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ABSTRACT

The Danish education system undergoes constant alterations due to the changes in the Danish society but maintains characteristic features through each educational reform. Section 1 provides a main outline of the education system for primary and lower secondary education, general upper secondary education, vocational education, and higher education. Section 2 describes vocational education and training as a highly developed democratic and dynamic system. Section 3 focuses on higher education and the contributory influence of students and the technical and administrative staff. Section 4 looks at Danish agricultural education, training, extension, and research. The fifth and final section presents internationally promising Danish research and education programs in the environmental area. (CK)

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ED 372 018

Education in Denmark

Characteristic Features of Danish Education

U.S. DEPARTMENT OF EDUCATION
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Main Outline of the Education System

The Danish education system is undergoing constant changes due to the changes in the Danish society. It is the aim of the Danish Government to maintain a high level of flexibility in order for the system to be able to adapt to changes and new goals and to ensure a high level of educational standards in the population so that it will meet the demands of the ever changing society and further its growth.

The education policy plays an important role in the efforts to promote growth in production and employment, increase the competitive power and improve the balance of payment of the country.

The active population (i.e. work-force) must possess knowledge and skills that allow them to adjust to new technology, changed production processes and new market conditions. The education system must thus be capable of renewing itself regularly with a view to adjusting to the requirements which international competition poses to a modern society in a global perspective.

In the past few years, comprehensive reforms have been implemented with a view to modernizing the courses of education, to granting a greater freedom to the educational institutions, and to obtaining a more efficient financial administration of education and training.

However, each educational reform has been characterised by preserving the fundamental qualities and elements of past systems that all parties have agreed have proven their right.

Primary and Lower Secondary Education

In Denmark, education is compulsory for 9 years with a voluntary 1year preschool class and a voluntary 10th school

year. At present, approx. 650,000 children attend this level of education.

The children start school proper when they are 6-7 years old. Parents have a free choice between the municipal school (the Folkeskole), where teaching is free, and the private elementary schools, where 15 per cent of the tuition fees are paid by parents. Approx. 90 per cent of the children attend the municipal school and 10 per cent the private elementary schools.

The pupils stay together throughout their entire school career. In the 8th to 10th forms, they may however choose an extended syllabus in a number of subjects. On completion of the 9th and 10th forms, the pupils may choose to sit for final examinations in the main subjects.

The Ministry of Education issues guidelines to the teaching in the individual subjects. Subsequently it is up to the individual school to work out a curriculum which is binding for the teachers. The teachers enjoy great freedom with regard to the planning and organization of their work within this framework.

The maximum teacher/pupil ratio is 1/28. The average ratio is 1/19.

General Upper Secondary Education

Upon completion of the 9th or 10th year of the Folkeskole, young people have the option of attending the 3 year general and academically oriented education offered by the Gymnasium (upper secondary school) which is completed by the Studentereksamen (upper secondary school leaving examination), and which qualifies for admission to higher education. Approx. 1/3 of the young people opt for this course after having been found qualified by their Folkeskole.

The Gymnasium comprises a mathematics and a languages line. In addition to the subjects of the two lines, students must choose to study another 3-4 elective subjects.

The majority of the Gymnasia are run and funded by the counties. There are however a number of private Gymnasia, with an enrolment of roughly 6 per cent of the students. They are governed by private boards and receive State grants which cover most of the operational expenditure of the schools. The average number of students per class is 25.

The 2-year Higher Preparatory Examination, the HF, also qualifies for admission to higher education. In order to be admitted to this course, the students must have taken the leaving examinations from the 10th form of the Folkeskole. The subjects are divided into common core subjects and elective subjects.

Vocational Education

More than half of a youth cohort enroll in a vocational education and training course. There is a wide range of specializations in the different main vocational fields.

The Danish Parliament lays down the overall framework of these courses which are organized in close cooperation between the Ministry of Education and the labour market parties.

The courses consist of a combination of practical training in a firm and theoretical and practical training at a school. In addition to the actual vocational subjects, general subjects are also taught. The courses normally last between 2 and 4 years. The period spent at school varies between 6 months and 2 years.

Next to the above basic vocational education and training courses, there are the higher commercial examination and the higher technical examination courses which are purely

schoolbased courses completed by an examination, and which qualify for admission to higher education.

The advanced technical and commercial courses mainly assume the completion of a basic vocational education and training course and are primarily theoretical courses of a duration of 1 to 3 years.

All these courses are meant to prepare their students for participation in production, marketing, service and other activities. The courses are well-represented throughout the country, and they provide national qualifications.

Higher Education

Over 15 per cent of a youth cohort enroll in higher education courses.

There are 5 traditional universities and a number of institutions offering specialized university level education, e.g. the Technical University of Denmark, the Royal Veterinary and Agricultural University, the Business Schools etc. All in all there are over 17 university-level institutions in Denmark. Furthermore, there is a wide range of institutions offering short and medium cycle non-university higher education, e.g. engineering colleges, teacher training colleges, schools of occupational and physiotherapy etc.

The State finances the operation of the higher education institutions.

The universities offer a wide range of study programmes leading to Bachelor's and Master's degrees. On completion of a Master's degree course, graduates may pursue their studies for the Ph.D.-degree. In addition to these degrees, there is the Danish Doctoral Degree which is awarded after an academic evaluation by specialists and public defence of a scholarly thesis which is often the result of many years of in depth research into the subject.

The universities and other institutions of higher education enjoy comprehensive autonomy, in that professors, students and technical and administrative staff occupy the seats in the governing boards of the institutions.

Most of the medium-cycle higher education courses take place at other educational institutions. These courses normally last 3 or 4 years leading to qualifications such as preschool and primary and lower secondary school teacher, social worker, physiotherapist, etc.

Vocational Education and Training

The Danish vocational college of today is an example of a highly developed democratic and dynamic system of "checks and balances".

The colleges are self-governing which means that they, on the one hand, have a high degree of freedom from local political influence and, on the other hand, that all local parties relevant to the programmes/courses are represented on the board of the self governing institution.

Equal Participation

Based on a principle of equal participation, the interested parties: county, municipality, employer, employee, students and different groups of staff are all represented on the board with a possibility of influencing the daily management of the college and the educational objectives as seen from a local point of view.

Influence from Central Authorities

The central authorities, in this case primarily The Ministry of Education & Research through the Department of Vocational Education and Training, define the overall educational policy with respect to the economic and subject-related/pedagogical framework.

The subject-related/pedagogical content of the various vocational programmes is defined and coordinated nationally by the Minister's advisory body: The Council for Vocational Education together with the National Trade Committees.

The national trade committees are all based on local committees who have the responsibility to ensure that the local conditions and requirements are met.

All the advisory committees are formed on the basis of the above mentioned principles of equal participation.

All in all it can be said that the structure of the Danish vocational education system facilitates a close contact between the different interested parties, especially it maintains a vital "lifeline" between the college and the local industry.

The Sandwich Model

The system of vocational education and training is based on the principle of alternating education meaning an alternation of periods of teaching at school and periods of training in a business enterprise.

The overall purpose of this system is to ensure a high level of professional expertise together with a correspondingly high level of adaptation to the demands and requirements of the production.

The periods of teaching at a vocational college are not only aimed at securing a technical and vocational competence within a narrow vocational framework but also to ensure through an element of basic education a uniform level with respect to professionalism and general knowledge.

The periods of practical training ensures that the education is relevant to the needs of the production. A professional basic education which is an interaction between periods of theoretical education at school and company-based practical training ensures that the apprentice by the time he/she finishes his/her education is ready for real life "production".

The Pedagogics of Vocational Education and Training

During the last decades there has been an increasing tendency in the vocational colleges to develop pedagogical ideas and ways of organization which are especially geared towards young people taking a vocational education.

The colleges being responsible for this kind of youth education must ensure that the apprentice, besides being professionally qualified, also has the opportunity of qualifying himself in general.

This means that the educational orientation of each student in general has four dimensions: an individual, a social, a professional and a sparetime dimension.

The pedagogical principles developed at the vocational colleges therefore must incorporate these four dimensions into a comprehensive teaching method, emphasizing each dimension differently during the course of study.

A Wide Range

A typical Danish vocational college will be able to offer education and training within a number of different main fields of trade.

The composition of these main fields of trade and their individual training programmes will reflect the character of the local economic life.

This, in turn, is contributory to the fact that the local colleges will be closely linked to the local conditions and as such act as a responsible partner in the economic development of the local community.

Transfer of Technology

It is relatively easy for the vocational colleges to have new technolgy and new production methods transferred from the economic life to the colleges and their training programmes.

New technology and new production methods are primarily transferred by way of centrally allocated funds for purchase of equipment together with funds for the further education and training of teachers. In addition to this there is among

the teachers a strong tradition for using their own sparetime to upgrade themselves.

Private Sponsoring

However, not all available funds for purchase of new equipment come from centrally government allocated funds. Locally private companies often find it in their interest to sponsor the acquisition of new equipment in order to contribute to the raising of their apprentices' educational level, be it within the company itself or in the trade as a whole.

The State Institute for Training of Vocational Teachers - the SEL

The SEL still plays a key role in providing courses for the upgrading of vocational teachers. However, the dominant role the institute used to play is now being challenged by private companies, trade organizations and technological institutes.

As the colleges themselves conduct inservice training and participate in development projects at many different levels, the acquired technological and professional knowledge will quickly be passed on to a wide range of different courseparticipants and companies to the benefit of the local industry.

Specialized Business and Technical Studies - Merkonom/Teknonom.

In Denmark we have a long popular tradition of lifelong education.

Within the vocational education and training system this has resulted in the creation of a special type of course (the merkonom/teknonom study programme) which is characterised by consisting of a number of common modules supplemented by different special modules and by taking place after normal working hours.

This type of education for instance gives a technically qualified employee the possibility of supplementing his technical qualifications with qualifications in economics, planning, management, marketing etc. - all according to the employee's own present and future need for new qualifications.
As a result, the individual company will get broadly qualified employees especially at middle management level who are flexible and being so will consequently have the opportunity and ability to participate at different levels and in different areas of production in the company.

Tailor-made Training

The vocational colleges are in competition with private suppliers offering tailormade training courses to local enterprises.

Most colleges are able to cover a wide range of different vocational areas and subjects all of which can be designed to meet the individual needs of different companies in different trades.

This type of activity is taking place on normal commercial conditions although there are to some extent some possibilities of getting public grants for this type of training.

Higher Education

In the late 60s, new principles of participation were introduced at the institutions of higher education.

Characteristically the students and the technical-administrative staff have a significant contributory influence on the activities of the institutions of higher education.

Strengthening of Management

However, contemporary trends in higher education development as well as the considerable resource-demands of this participation system challenge the philosophy of this management system.

In order to make the institutions more efficient and capable of meeting the demands and future challenges, there is a growing political demand for a stronger and more pronounced management of the institutions.

New Model for Budgetting

In 1980, a new budgetting model was introduced. A tool based on the use of EDP by which public funds are computed and allocated between different institutions and their individual academic fields.

This new budgetting model solved some fundamental problems of budgetting mass-education in a period of big youth cohorts.

The need for funding is computed as a sum of the active study periods of each individual student combined with a factor giving the relationship between the number of students and the necessary number of teachers (i.e., the student/teacher ratio).

In this connection, a number of parameters for annual expenses were developed. Manpower for research and development are, however, budgetted independently.

Through the development of this new model of budgetting, a consistent, transparent system was created, based on equal and uniform economic management of homogeneous fields of education.

Commercial Cooperation

In recent years the institutions of higher education have opened up for cooperation with private enterprises, public authorities and different organisations.

This had developed through use of the market-oriented budgetting system, the socalled

Income-Generating Activities

These activities include research, development and education - production which are offered to external customers.

Through the use of income-generating activities, market oriented mechanisms have been introduced into the work of the institutions of higher education.

This policy is based on the belief that the best conditions for innovation and quality are created, when a substantial part of the overall responsibility and competence lies with those people who are going to carry out the activities.

Ability to Readjust

For some years it has been a professed goal to obtain readjustment - and an ability to readjust - within the higher education system in order to meet the new needs for qualified manpower.

Bearing this in mind, part of the overall budget for higher education has been singled out in special adjustment pools.

In this way especially a number of new educational programmes have been established, e.g. in computer science and commerce and economics.

A number of combination study programmes have also been established, e.g. business language programmes have been combined with market economic elements, and market economic programmes have been combined with parts of the programme in law.

Through these initiatives, computer science has also been incorporated in several other study programmes.

Internationalization

The internationalization of Danish higher education is speeding up in these years through:

- exchange programmes for students and teachers.
- projects of cooperation between institutions across frontiers,
- efforts to make study programmes or parts of these comparable to corresponding study programmes in other countries.

All of this with a view to creating international cooperation among institutions of higher education together with mutual knowledge and recognition of diplomas for national study programmes of individual countries.

This development has among other things had the consequence that some institutions of highert education in Denmark have introduced lectures or even a full course in English and in a few cases also lectures in French and German.

Quality in Education

Under the headline: Quality - radical attempts have recently been made to strengthen the quality of the study programmes and the teaching itself.

These attempts include the vertical connection between educational levels, e.g. between secondary level (the upper secondary school - gymnasium) and tertiary level.

Funding of Research & Development

By the end of the 1980s, something like 48% of the total R&D expenditure was financed by the private business enterprise sector, some 46% by the government sector and the remaining 6% by private organizations and funds, and by foreign sources.

Business Enterprise Sector

While financing around 48% of the total R&D, the private business enterprise sector at the same time undertook R&D for 56% of the total R&D expenditure.
This signifies an added net of R&D resources to the private business enterprise sector.

R&D Ratio

Comparing Denmark to the major OECD countries with respect to the share of total R&D expenditure in relation to the gross domestic product (GDP) shows that so far we have a relatively low R&D ratio (approx. 1.4 %).

This difference in the R&D efforts is especially determined by the business enterprise sector R&D.

In fact, the private business enterprise share of the R&D expenditure was about 2% of the GDP in the USA, Sweden and (West) Germany, and only 0.8% of the GDP in Denmark in 1987.

Business Enterprise R&D

The research and development efforts are concentrated in five branches of industry. In 1987, machinery, electronics, pharmaceuticals, instruments and other chemicals performed 74% of the industrial R&D work while employing only 35% of the labour force in industry.

Public Sector R&D

Slightly under half of the Danish R&D is carried out in the public sector, consisting of two sectors of almost equal importance: the university sector and the other public sector.

The university sector comprises 17 universities and institutions of higher education. The other public sector consists of e.g. hospitals, libraries, museums, government research establishments, etc.

Off Budget Financing

76% of the total public sector R&D expenditure was financed by basic budget appropriations from central or local government. Offbudget financing include programme funds from the public sector, grants from private funds and organizations, resources from the private business enterprise sector, and from abroad.

Offbudget financing is increasing its share, from 16 per cent in 1981 to 24 per cent in 1987.

Share of Basic Research

Research activities may be split into basic research, applied research, and experimental development.

77% of the basic research activities in the public sector takes place in the university sector.

Characteristically (ever since the early 1970s) basic research has remained constant at around 40% of the total R&D activity in the government sector, although the offbudget financing doubled in the same period.

The increased off budget financing of research has not provoked any decline in the share of basic research.

Danish Research Academy

The Danish Research Academy (DRA) (Forskerakademiet) was established in 1987 as part of the government's action plan to further Danish R&D.

The DRA was meant to be an untraditional and efficient organization responsible for the coordination of the graduate programmes offered by the Danish universities and academic higher education institutions.

All programmes are aimed at increasing the cultural, economic and scientific competitiveness of the Danish society.

All activities are related to formalized Ph.D studies.

Aims of the Action Plan

The overall aim of the plan is to double the R&D effort in Denmark in proportion to the GDP before the year 2000.

Other objectives are:

- to strengthen the education of researchers in a close cooperation between universities, other public research institutions and the research departments of private enterprises.

- to further the internationalization and quality of Danish Ph.D programmes.

- to double the number of Ph.D students before the year 2000.

The Stimulation Programme

To further the internationalization and the quality of Danish Ph.D programmes, the Academy funds long term studies abroad for Danish Ph.D students.

It also funds foreign scientists' visits to Danish Ph.D programmes as either professors or guest students provided that

they are recommended by the Danish research institutions. The Academy initiates and funds international summer schools and advanced level courses.

Supporting the student as well as the professor may be seen as an element of a strategy to build up an attractive programme resulting in strong and lasting ties between foreign and Danish institutions.

Introductory Scholarship Programmes

To facilitate the introduction of young Danish researchers into Ph.D programmes, the Academy funds 300 one-term fellowships of 36 months to cover interim periods between date of graduation and accepted Ph.D programme.

Joint Financing

A joint scholarship programme has been created to establish the Ph.D-level as the level of qualification of the future Danish researchers beyond the basic research sectors.

Danish Agricultural Education, Training, Extension and Research

Introduction

Danish agricultural research goes hand in glove with education and extension. The agricultural degree programmes are offered by the Royal Veterinary & Agricultural University (RVAU), while agricultural schools organize training of young farmers.

Agricultural research is mainly carried out at the university under the Ministry of Education and Research and at the agricultural research institutions under the Ministry of Agriculture. The Danish Agricultural Extension Service is mainly organized by Farmers Associations, and by larger co-operatives and even private companies active in Farm Input Supply or Commodity Processing.

1. Agricultural Education

1.1. University level

Higher education in veterinary medicine and agricultural sciences is offered at the Royal Veterinary & Agricultural University only.

The Danish Agricultural University comprises three faculties, viz.:

- Faculty of Animal Science and Veterinary Medicine
- Faculty of Agricultural Science
- Faculty of Food Science and Basic Science

Degrees are obtainable in

- veterinary science,
- agricultural science,
- horticultural science,
- sylvycultural science,
- dairy science, and
- food science.

The degrees conferred are
1. Kandidat (M.Sc. degree level)
2. Ph.D.
3. D.Sc.

As to the first degree, it may be noted that, recently a B.Sc. degree was introduced, available upon request and after satisfactory completion of three years of studies.

At the RVAU, there are some 3,000 students, and nine hundred staff, some 250 teaching. In recent years there has been a significant increase in Ph.D. research projects.

1.2. Danish Agricultural Training

Out of a total of 31 agricultural schools, 24 offer training for farmers at basic and up to diploma-level. It is noteworthy that the training programmes combine theory and practice roughly 50:50.

The recent and newly introduced training structure consists of four so-called "modules", see below. Trainees may leave after completion of any one module, or take all, which would last 51 months total, 26 months being practical work as hired hands on farms.

The modules are
- basic training
- qualified farmer training
- manager training (certificate)
- advanced manager training (diploma).

One of the schools has specialized in ecological agriculture, while two offer a diploma in agro-economy. The remaining seven schools operating under the heading Agricultural Training Institutes are
- two schools offering diploma level training only, in Agricultural Management available in English, and in general agriculture with subject specialization,
- two schools covering horticulture per se, and

- three schools which offer continuing training of extension personnel and of farmers.

While all schools have a core programme, they would be prepared to mount special programmes, which could well be offered in English, and be a combination of theory and practice.

The technical schools also offer vocational education and training in agriculture, horticulture, and forestry as one of 8 main vocational fields into which all the various vocational training courses are grouped. The training consists of theoretical instruction at a school as well as on-the-job training.

2. Agricultural Research

The institutions under the Ministry of Agriculture are responsible for the major part of Danish research in Agriculture.

Research at the Royal Veterinary & Agricultural University also plays a major role. Other institutions carrying out agricultural research belong to the Ministry of Energy, the Ministry of the Environment and the Ministry of Health.

Recently, a special Danish biotechnology research programme was initiated by the Ministry of Education and Research. Through this a connection of efforts on biotechnology in animal and in plant production has been achieved by RVAU as well as by research institutes of the Ministry of Agriculture.

A brief list of Danish agricultural research institutions is given below. The term research is used mainly in the sense of basic and applied research and covers for some institutions also development/demonstration.

1. The Ministry of Agriculture

- Danish Institute of Plant and Soil Science
- National Institute of Animal Sciences

- Danish Agricultural Engineering Institute
- Institute of Agricultural Economics
- Danish Forest Experimentation Station
- Danish Pest Infestation Laboratory
- Veterinary Serum Laboratory
- Veterinary Institute for Virus Research

2. The Royal Veterinary & Agricultural University
The research profile of RVAU is characterized by experimentation within, and in support of disciplines where degrees are granted, Ph.D. research projects, and D.Sc. research projects.

- Department of Anatomy and Physiology
- Department of Pharmacology and Pathobiology
- Department of Animal Science and Animal Health
- Department of Clinical Studies
- Department of Veterinary Microbiology
- Department of Botany, Dendrology and Forest Ge netics
- Department of Ecology and Molecular Biology
- Department of Plant Biology
- Department of Economics and Natural Resources
- Department of Agricultural Sciences
- Department of Dairy and Food Sciences
- Chemistry Department
- Department of Mathematics and Physics
- Research Department of Human Nutrition

A further source of development and adaptation of RVAU appears through emanating centres for Tropical Agriculture and Environment, and for Agricultural Ecology.

3. Ministries other than those of Education and Research and Agriculture are also concerned with agricultural research
- Risø National Laboratory (Ministry of Energy)
- National Environment Research Institute (Ministry of the Environment)
- The National Food Agency (Ministry of Health)

- The Biotechnical Institute (an independent institu tion linked with the Academy of Technical Sciences)
- Danish Land Development Service (an independent institution but subsidized by the Ministry of Agricul ture)
- The Meat Research Institute (is run by the abattoirs and the meat canning industries).

4. Other Institutions

This heading could include a number of private and co-operative improvement stations working within the fields of agricultural, horticultural and sylvicultural plants.

In addition, Danish International Development Agency (DANIDA) funds three centres in Denmark related to agriculture, viz.:

- The Seed Pathology Institute for Developing Coun tries. - This institute is now associated with RVAU.
- The Danish/FAO Forest Tree Seed Centre.
- Danish Bilharziasis Laboratory.

3. Danish Agricultural Extension

Agricultural Extension is organized primarily by the agricultural societies, secondarily by larger cooperatives, i.e. abattoirs, dairies, and farm input suppliers and thirdly by private companies dealing i.e. in chemicals like herbicides and pesticides. Extension officers would typically hold a degree from RVAU or a diploma from an agricultural training institute. Traditionally, agricultural extension is not taught as a specific discipline at the RVAU.

The extension officer, whom a farmer would call for advice in a given situation would be employed by the farmers' own society, and therefore, would represent the farmers interests. Other extension officers offer their advice on their own initiative.

The agricultural extension officer is supported technically through the Danish Agricultural Advisory Centre, whose

staff of nearly a hundred subject specialists are available for consultation. They, of course, would be in close contact with the research establishment.

4. Final remarks

The driving force in Danish Agriculture is the liberal, market economy oriented farmer. He has the decision to chose any production he prefers, either because he has been trained to know, or because he has heard about it through extension officers, publications or otherwise. The farmer will energetically request advice if needed, and will thus start the ball rolling to subject-specialists and to researchers, and thereby establish a feed back.

Overview of Research and Higher Education in the Environmental Area

Introduction

The aim of this overview is to present internationally promising Danish research and education programmes in the environmental area. The environmental area is defined to the relations between the sources, the effects on the ecosystems and the environmental regulation.

Public environmental regulation

The environmental problems are results of the societal development, and therefore a current change is taking place. Where it was previously considered possible to reduce the environmental problems by regulating, and if possible prohibiting, the use of some chemical substances, most people admit today that the environmental problems are of a very complex nature.

This assessment takes its point of departure in the total picture, which encompasses both social sciences and natural sciences disciplines. The establishment of the best possible public environmental regulations justifies a great deal of scientific research and higher education.

Environmental Research

Environmental research is carried out at many institutions in Denmark. When evaluating the natural sciences/technological part of Danish environmental research, an international expert panel visited 77 institutions which receive public funding (the Danish Council for Scientific Policy and Planning, International Evaluation of Danish Environmental Research, 1989). These institutions are located at the universities, at sector research institutions and at the affiliated institutions of the Danish Academy of Technical Sciences. This multitude of research institutions is an ex-

pression of the fact that the universities include the environmental problems in many of the traditional subjects, and over time departments oriented towards environmental research have been set up.

Effective supervision and regulation instruments of the environmental policy have been a part of a high priority social sciences research area. In the past few years, market-oriented instruments such as taxes have become the subject of several projects. The same goes for the economic barriers for the use of less polluting production methods and technology.

The weighting of the cleaner technology has been strengthened in recent years in connection with the interest in the report submitted by the BrundtlandCommission with the key-concept of "sustainable development", which is pointed out as a basic strategy in the environmental area and integrated also into action plans for energy, agriculture and transport. This has led to several projects at a number of research institutions working with different sides and sector views. A "Brundtland Institute" is about to be established.

The research conducted at the sector research institutions is oriented towards application. By the creation of the National Environmental Research Institute (the NERI) as a part of the Ministry of the Environment, a basis has been created for an effective environmental research institution.

In order to be able to handle environmental problems, research initiatives have in recent years been taken in whole areas, e.g. the energy sector and the pollution problems of agriculture. This new orientation has led to a necessary shift in the environmental research towards source-oriented research.

The Danish research in the environmental area has been evaluated in relation to important Danish environmental problems in the 1980s (the NEMgroup, Environment in the

Nordic Countries and in the EC. Report elaborated for the Nordic Council of Ministers, 1990).

Fish Death and Oxygen Depletion in Marine Areas

The Danish marine environment regulation is built up around the ability of nature to transform certain polluting matters with acceptable consequences. The background of this planning system is the pluriannual and comprehensive Danish research tradition which exists in relation to marine ecosystems. Danish research is trend-setting in the world in the field of eutrophication problems and over-fertilization problems in areas of brackish water.

Oxygen depletion problems are coupled to the eutrophication in the inner Danish waters, and agriculture is considered to be a considerable source for the oxygen depletion phenomena. A comprehensive research programme on nitrogen-phosphorous and oxygen has just been completed. Ongoing programmes deal with wast-water areas and with sea pollution.

A marine environment plan adopted in 1987 has led to an extension with both chemical and biological waste-water cleaning. We have well-established development and testing experience with waste-water cleaning technology in Denmark.

Energy and Environment - incl. Acidification, Renewable Energy and Planning

Both the energy consumption and the energy production and provision have since the end of the 1970s been the subject of a considerable research and investigation effort at several research institutions. As an element of the energy planning, investigative methods, models for the use of the elaboration of scenarios and regulation and control instruments have been developped.

Also the technical sides of energy saving, optimization of equipment and environmental technology (e.g. desulphurization technology) have led to a great number of projects.

Finally, renewable energy sources such as wind and solar energy have led to a number of projects - on the one hand as an element of the energy planning and on the other hand of a more technical and implementation-oriented nature. The same applies to the development of the bio-mass-based energy sources, in particular bio-gas, straw and wood/chips.

Acidification with Sulphur-Dioxide and Nitrogen-Oxide and Deforestation

From the middle of the 1980s, a debate has been ongoing in Denmark on deforestation and of its connection to air pollution. The effects of acid rain on forest-soil are investigated in Jutland at a field-station which forms part of a European cooperation project.

Development work is taking place around desulphurization technology in connection with for example power stations.

Chemical Industries and Risk

Eco-toxicological research in environmental poisons and their effects on nature is being conducted at many institutions in Denmark.

The development of environmental evaluation methods and cleaner technology is a society-oriented technological research which has a planning objective.

Biotechnology and Environment

The research and regulation concerning the consequences of placing genetically engineered organisms in nature are of great importance.

Environmental Education

At the Danish higher education institutions, environmental education is typically offered through special courses within

the subject disciplines, i.e. in the study programmes in biology, chemistry, law etc. the students can choose to specialize in the environmental area. The result has been that the Danish environmental education is spread on many and relatively small units.

Biology Studies

At the University of Copenhagen, it is possible on the second part of the study programme to gather courses for a specialization in environmental control which aims at public and private combat of pollution.

The study programme in environmental biology at Roskilde University puts an emphasis on developing the skills in biological and microbiological areas and the combination with chemistry.

Many of the specializations in the biology study programmes at the Universities of Copenhagen, Aarhus, Odense and Roskilde have a considerable environmental content, including an ecotoxicological objective.

The Engineering Courses

The Technical University of Denmark, Aalborg University and the Engineering Academy of Denmark train engineers who have specialized in technical hygiene and environmental techniques.

The Laboratory of Environmental Science and Ecology of the Technical University of Denmark offers a special course and, in 1987, 7 students graduated in this field. The general development in the education of environmental engineering graduates is towards more specific courses in mathematics, edp, chemistry and biology.

Courses at the Royal Veterinary and Agricultural University

At the Royal Veterinary and Agricultural University, students can specialize within the environmental area by choosing in the last year of the study programme between a

panoply of relatively short courses on among other things environmental administration, environmental technology, and alternative energy all with connection with agriculture.

The Social Sciences Subjects

Within Law and Economics, courses are offered in special environmental areas, e.g. environmental law, environmental economics and environmental politics, including all planning aspects.

In addition to this subject-divided environmental education, there are a few institutes which offer problem-oriented interdisciplinary environmental education.

Problem-oriented Interdisciplinary Environmental Education

Roskilde University offers a degree course in technological-social science planning in which the environmental - and the natural sciences - aspects can be recurrent in an individually organized study programme.

The land surveying course at Aalborg University comprises elements of environmental planning.

The joint environmental course of the higher education institutions is a cooperation programme in the Copenhagen-area with a view to giving the students on the second part studies a possibility of working with environmental problems on an interdisciplinary basis.

The environmental course at Aarhus University is an interdisciplinary teaching unit which provides knowledge of the various fields of Natural Sciences, Medical Sciences, Social Sciences and Humanities.

Further Training in the Environmental Area

There is a comprehensive further training programme in the environmental area in Denmark. The rapid development of the environmental problems and the changes in the environmental regulation have led to a great need for further training

programmes in environmental issues. The Danish Association of Engineers, Roskilde University, Aarhus University, Aalborg University among others offer further training activities for many different target groups. Roskilde University has for instance arranged further training courses for staff employed in the Ministry of the Environment for a number of years.

With the recent opening towards Eastern Europe, part of the cooperation with this part of the world has consisted of further planning and training programmes in the environmental area. These programmes have been organized by consulting engineers and planners and by universities and polytechnics. In the environmental area, a broad cooperation has been established between private consultancy firms, technical institutes, universities as well as central and local authorities. This cooperation makes it possible to implement coherent projects which comprise legal, administrative, theoretical and practical solutions both to general and to concrete environmental problems. In some cases, these parties have conducted joint programmes in close cooperation with partners in Eastern and Central Europe and in the Baltic Republics.

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